MEMORANDUM

TO: Amy Hambrick, U.S. EPA, Sector Policies and Programs Division/Natural Resources and Commerce Group

FROM: Eastern Research Group, Inc.

DATE: January 2011

SUBJECT: Revised Secondary Impacts of Controls for the Sewage Sludge Incineration Source Category

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1.0 INTRODUCTION

This memorandum presents the secondary impacts associated with control devices used to comply with the proposed standards for existing and new sewage sludge incineration (SSI) units. Secondary impacts result from the consumption of fuel, water, and electricity and generation of solid wastes by control devices.

Section 2.0 presents the background for the proposed standards. Section 3.0 presents the secondary impact estimates associated with control devices necessary for all SSI units comply with proposed standards. This memorandum focuses only on secondary impacts associated with control devices. Section 4.0 summarizes the estimated secondary impacts that would result from the compliance of new units expected to come online in the next five years. Section 5.0 summarizes the emissions resulting from increased fuel and electricity requirements for different controls.

2.0 BACKGROUND

The U.S. Environmental Protection Agency (EPA), under section 129 of the Clean Air Act (CAA), is required to regulate emissions of 9 pollutants from existing sewage sludge incineration (SSI) units. The 9 pollutants are: hydrogen chloride (HCl), carbon monoxide (CO), lead (Pb), cadmium (Cd), mercury (Hg), particulate matter (PM), total mass basis dioxins/furans (TMB PCDD/PCDF) and toxic equivalency basis dioxin/furans (TEQ PCDD/PCDF), nitrogen oxides (NO_x), and sulfur dioxide (SO_2). The CAA requires EPA to determine the maximum achievable control technology (MACT) for each category or subcategory of sources. The SSI source category comprises two subcategories: multiple hearth incineration units (MH) and fluidized bed incineration units (FB). To determine the MACT for each subcategory, EPA must first determine the minimum stringency "floor" requirements. Development of the MACT floors for SSI units is described in a separate memorandum.[1] An analysis of beyond-the-floor controls was also conducted, in which three different control combinations were evaluated:

- Combination 1 is the MACT floor level of control for the two subcategories developed for existing multiple hearth (MH) units and fluidized bed (FB) units.

- Combination 2 is the MACT Floor level of control, with the addition of afterburner retrofits for additional CO emissions reduction from MH units not already having an afterburner.
- Combination 3 is the MACT Floor level of control, afterburner retrofits for MH units not already having them, and the addition of activated carbon injection (ACI) in combination with a fabric filter for MH units for additional Hg and PCDD/PCDF emissions reduction.

3.0 SECONDARY IMPACT ESTIMATES FOR EXISTING UNITS

For the control combinations listed above, facilities may need to install the following types of control devices on SSI units:

- Venturi scrubbers (VS) or wet electrostatic precipitators (WESP) to reduce Cd, Pb, and PM emissions,
- Packed-bed scrubbers (PBS) to reduce HCl and SO_2 emissions,
- Selective non-catalytic reduction (SNCR) to reduce NO_x emissions,
- ACI systems, in combination with a FF, to reduce PCDD/PCDF and Hg emissions, and
- Afterburners (AB) to reduce CO and organic compound emissions.

Electricity is required to operate the pumps and fans associated with WESP, VS, PBS, FF, and SNCR systems. Also, water and subsequent wastewater disposal are required to operate VS, WESP, and PBS systems. Fabric filter and ACI systems require a method to dispose of the dust produced from the systems. Additionally, ACI requires the use of activated carbon. Supplemental fuel (i.e., natural gas) is required to operate afterburners for MH SSI units.

Table 3-1 shows, for each of the controls analyzed, the estimated secondary impacts for the FB and MH subcategories.

The algorithms used in the cost analysis provide annual cost estimates for electricity, water, carbon requirements, and supplemental fuel as itemized components of the annual costs for the control device.[2,3] These cost elements for the control devices anticipated to be installed to comply with the standards were then summed to provide an estimate of the overall costs of electricity, water, activated carbon, and supplemental fuel. To estimate the secondary impact components (e.g., electricity, water, dust), the itemized annual cost of each component was divided by the unit price of the component used by the algorithm.

Table 3-1. Secondary Impacts for Controls Analyzed

Controls Analyzed	Sub-category	Controls Required for Compliance	Electricity Required (MW-hr/yr)	Water Required (gal/yr)	Activated Carbon Required (ton/yr)	Dust Produced (ton/yr)	Supplemental Fuel (mmcf ft^3 natural gas/yr)
1 - MACT Floor	FB units	PBS, SNCR	505	32,035,300	-	-	-
	MH units	VS, WESP, PBS	4,915	202,325,500	-	-	-
	Total	VS, WESP, PBS, SNCR	5,420	234,360,800	-	-	-
2 - MACT Floor + AB for MH units	FB	PBS, SNCR	505	32,035,300	-	-	-
	MH	VS, WESP, PBS, AB	4,915	202,325,500	-	-	1,013
	Total	VS, WESP, PBS, SNCR, AB	5,420	234,360,800	-	-	1,013
3 - MACT Floor + AB and ACI/FF for MH units	FB	PBS, SNCR	505	32,035,300	-	-	-
	MH	VS, WESP, PBS, AB, ACI/FF	43,185	202,325,500	4,370	4,890	1,013
	Total	VS, WESP, PBS, SNCR, AB, ACI/FF	43,690	234,360,800	4,370	4,890	1,013

4.0 SECONDARY IMPACT ESTIMATES FOR NEW UNITS

As discussed in the new source analysis memorandum, EPA expects that two new FB units would come online in the next five years[4]. Estimations of the secondary impacts resulting from the pollution controls implemented for these units were calculated using the same methodology described for existing units in Section 3.0.

Table 4-1 shows the estimated values for secondary impacts for the two new FB units.

Table 4-1. Secondary Impacts: New Units

Sub-category	Controls Required for Compliance	Electricity Required (MW-hr/yr)	Water Required (gal/yr)	Activated Carbon Required (ton/yr)	Dust Produced (ton/yr)	Supplemental Fuel (mmcf natural gas/yr)
New Units	PBS, ACI/FF, AB	597	17,172,000	67.0	67.9	16.7

5.0 SECONDARY AIR POLLUTANT IMPACTS

Emission factors from EPA's Egrid[5] database were used to calculate emissions resulting from the electricity required for additional control devices, and emission factors from EPA's AP-42 emission factor document[6] were used to calculate emissions resulting from the combustion of additional fuel for afterburners. Increased electrical use from the controls will require additional

fuel to be burned in power plants, resulting in emissions of CO_2 and criteria pollutants, such as SO_2, NO_x, and CO. Emissions of these pollutants (caused by increase in electricity) were estimated using EPA's Egrid database.[5] The Egrid database summarizes emissions of criteria pollutants on a per electrical usage basis (lb emitted per MW-hr), on a national average or state average basis. For this analysis the national average was used. Afterburners require supplemental fuel , such as natural gas, to operate. The afterburner algorithm indicates the amount of fuel needed by each unit. To estimate emissions from combustion of natural gas, emission factors from EPA's AP-42 emission factor document were used.[6] Tables 5-1 summarizes the resulting emissions of CO_2, CO, NO_x, and SO_2 from combustion of natural gas supplemental fuel and increase electricity usage for the three control combinations analyzed for existing sources. Table 5-2 shows the results for new sources, and table 5-3 shows results for combined existing and new sources. Table 5-4 shows the Egrid and AP-42 emission factors used for the calculations.

REFERENCES

1. Revised MACT Floor Analysis for the Sewage Sludge Incinerator Source Category. Memorandum from Eastern Research Group, Inc. to Amy Hambrick, U.S. Environmental Protection Agency. January 2011.

2. Revised Cost and Emission Reduction of the MACT Floor Level of Control. Memorandum from Eastern Research Group, Inc. to Amy Hambrick, U.S. Environmental Protection Agency. January 2011.

3. Revised Analysis of Beyond the Maximum Achievable Control Technology (MACT) Floor Controls for Existing SSI Units. Memorandum from Eastern Research Group, Inc. to Amy Hambrick, U.S. Environmental Protection Agency. January 2011.

4. Revised Estimation of Impacts for New Units Constructed Within Five Years After Promulgation of the SSI NSPS. Memorandum from Eastern Research Group, Inc. to Amy Hambrick, U.S. Environmental Protection Agency. January 2011.

5. EPA eGRID database eGRID2007 Version 1.1. Year 2005 summary tables located at www.epa.gov/cleanenergy/documents/egridzips/eGRID2007V1_1_year05_SummaryTables.pdf

6. U.S. Environmental Protection Agency, 1995. Compilation of Air Pollutant Emission Factors (AP-42), Fifth Edition, Volume 1: Stationary and Point Sources, Chapter 1: External Combustion Sources.

Table 5-1. Secondary Air Pollutant Impacts: Existing Units

All Units Comply												
	Electricity Requirements and Emissions (tons/yr)*				**Supplemental Fuel Requirements and Emissions (tons/yr)***				**Total Secondary Emissions (tons/yr)**			
Controls Analyzed	MWh per yr	CO_2 Emitted	NO_x Emitted	SO_2 Emitted	ft^3 Natural Gas per yr	CO_2 Emitted	CO Emitted	NO_x Emitted	CO_2 Emitted	CO Emitted	NO_x Emitted	SO_2 Emitted
1 - MACT Floor	5420	3602	5.2	14.3	-	-	-	-	3,602	-	5.2	14.3
2 - MACT Floor + AB for MH units	5420	3602	5.2	14.3	1,013,417,920	60,805	42.6	50.7	64,407	42.6	55.9	14.3
3 - MACT Floor + AB and ACI/FF for MH units	43689	29039	42.3	114.9	1,013,417,920	60,805	42.6	50.7	89,844	42.6	93.0	114.9

*Emissions estimated based on emission factors listed in Table 5-4.

Table 5-2. Secondary Air Pollutant Impacts: New Units after Five Years (2 New Units)

Electricity Requirements and Emissions (tons/yr)*				**Supplemental Fuel Requirements and Emissions (tons/yr)***				**Total Secondary Emissions (tons/yr)**			
MWh per yr	CO_2 Emitted	NO_x Emitted	SO_2 Emitted	ft^3 Natural Gas per yr	CO_2 Emitted	CO Emitted	NO_x Emitted	CO_2 Emitted	CO Emitted	NO_x Emitted	SO_2 Emitted
597	397	0.58	1.57	16,659,400	1000	0.70	0.83	1,397	0.70	1.41	1.57

*Emissions estimated based on emission factors listed in Table 5-4.

Table 5-3. Secondary Air Pollutant Impacts: Combined Existing and New Units after 5 Years

	Total Secondary Emissions (tons/yr)			
Controls Analyzed	CO_2 Emitted	CO Emitted	NO_x Emitted	SO_2 Emitted
1 - MACT Floor	1,397	0.7	6.6	15.9
2 - MACT Floor + AB for MH units	65,804	43.3	57.3	15.9
3 - MACT Floor + AB and ACI/FF for MH units	91,241	43.3	94.4	116.5

Table 5-4. Emission Factors

Pollutant	Electricity[a]	Natural Gas[b]		
	(lb/MWh)	(lb/10^6 scf)	(lb/ft^3)	(ton/ft^3)
CO_2	1,329	120,000	0.12	0.00006
CO	-	84	8E-05	4.2E-08
NO_x	1.9366	100	0.0001	5E-08
SO_2	5.2589	-	-	-

a. National emission factors from Egrid[5] for EGUs.
b. Natural gas emission factors from AP-42